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APPLE ROOTSTOCKS

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The traditional concept that an orchard is a lifetime venture must be scrapped. High land values and increases in all other farming costs make it imperative that an early return on the investment be realized.

Do you realize that you can plant an apple orchard that has built-in controls? Dwarfing rootstocks control wood production in the tree, directing its energy into fruit production. By choosing the rootstocks for your needs and conditions, you can preselect, to a considerable extent, the size of your orchard trees at maturity. This choice, in itself, can save a great deal of labor in pruning and picking, and time waiting for your trees to start cropping.

Dwarf trees grow apples where most, if not all, of the fruit can be picked without ladders. To improve efficiency in the picking operation and to increase yield per hectare, dwarf to semi-dwarf trees are planted at close intervals in the rows. This type of high-density planting provides a continuous tree wall of bearing surface to be sprayed and picked, thus reducing waste of time and materials.

High-density relates to maximum light interception by the leaves of the trees rather than specifically to the number of trees per hectare. For maximum light interception to occur, a minimum amount of sunlight is lost on the ground between trees. It has been shown that fruit size and total fruit production increases when light interception and utilization are increased. In general, the more dwarfing the rootstocks, the better they lend themselves to high-density planting, with early economic return.

The Malling and Malling-Merton clonal rootstocks, whose descriptions follow, were selected for conditions in England. They were not bred or selected for winter hardiness in Canada. Consequently, the roots or stems suffer cold injury occasionally in certain locations across Ontario. Excessive cultivation or feeding that induces late, immature growth should be avoided. Sod cover with mulch under the trees provides protection for the roots against extremes of temperature.

Depending on which rootstock is used, apple trees may be broadly classified into four categories: **dwarf, semi-dwarf, semi-vigorous** or semi-standard, and **vigorous** or standard size. These are relative terms, and it must be understood that tree size at any age will vary with the cultivar, the soil, nutrition, pruning practices, amount of cropping, and climate.

DWARF TREES

Dwarf trees do not produce dwarf fruit. The two rootstocks available commercially for dwarfing apple trees are Malling 9 and Malling 26. When properly pruned and cared for, dwarf trees on these stocks produce larger fruit than trees on more vigorous rootstocks.

Malling 9 makes a tree approximately 25% of full size. It is recommended as a rootstock for intensive production of dessert apples especially on fertile soils in the warmer parts of Ontario. Tree population may range from a minimum of 750 trees per hectare to 2,500 or more.

Dwarf trees on M.9 are not necessarily short-lived or shallow-rooted. Root development is proportional to tree height and spread. In time of drought the dwarf tree has a smaller volume of soil to supply water than a vigorous tree. The wood of the M.9 stock is brittle and will break suddenly under stress. Therefore, trees on M.9 should be supported by tying them to individual posts or by training as palmettes and tying to a wire trellis on posts 6 to 10 m apart. If tied to individual posts, training should be to a modified central leader or, if very high-density, to a slender spindle.

Malling 26 rootstock provides the smallest tree that can be reliably grown without support. The tree is about 40% of standard size, being larger and sturdier than M.9 but smaller than M.7. M. 26 is recommended in all apple districts of Ontario, but on a trial basis only in colder districts east of Hastings county. Commercial stocks are virus-free and are in great demand in Ontario.

Trees on M.26 are precocious, but should not be allowed to crop the first 4 years unless tree numbers exceed 1000 per hectare. As trees seldom average 2 bushels per tree until the tenth year, 750 or more trees per hectare should be planted. The trees respond to intensive training and pruning similar to trees on M.9.

Tolerant to heavy clay soils, M.26 has good resistance to collar rot. The roots are not brittle like the roots of M.9. M.26 is apparently susceptible to fireblight but no losses from fireblight have been found in Ontario. As a precaution against infection, rootstock suckers should be removed promptly.

Two other dwarfing rootstocks are *Malling 27* and *Ottawa 3*. Neither is recommended for general planting at this time(1990). M.27 is probably too dwarfing to be useful in commercial orchards. It makes a tree about half the size of one on M.9 or smaller. As it is a slow, weak grower in the stoolbed, special techniques will be required to produce plants in quantities for commercial use. Ottawa 3 is the most dwarfing rootstock to come out of the cold-hardy breeding program at Ottawa. It appears more dwarfing than M.26 but more vigorous than M.9. Ottawa 3 roots sparsely in the stoodbed, but can be grown from root cuttings. Its orchard performance has not been determined. It is not recommended where Malling stocks are satisfactory.

Dwarfing Interstocks: Dwarf trees can be obtained by using dwarfing interstocks on vigorous rootstocks. Productivity is usually proportional to tree size. Staking is advised where M.9 or other brittle interstock is used.

General planting of interstock trees is not recommended in Ontario because of additional costs, the inherent suckering, and the confusion that can occur with depth of planting and the multiple number of possible stock, interstock and scion combinations. In unusual situations such as in coldest districts, 0.3 on Robusta 5 may be tried. Growers wishing to plant interstem trees should order from a nurseryman 1 or 2 years in advance, accompanied by a down payment.

SEMI-DWARF TREES

Many trees were planted on semi-dwarfing rootstocks in the '50's and '60's, popularity resting with Malling 7 at first, but later swinging to MM.106. Both are now in less demand than M.26.

The planting of the so-called semi-dwarf apple tree has been a compromise between the big standard apple tree that requires much ladder work and the small dwarf tree that can be pruned and picked from the ground. By the time the semi-dwarf tree attains sufficient size to crop satisfactorily, some ladder work is required to pick and prune. As semi-dwarf trees have a limited bearing area, the orchardist is advised to plant more than 250 trees per hectare for economic production.

Malling 7 gives a tree a little larger than M.26 and smaller than MM.106. It performs best on a good soil in a location protected from the wind, in a district with relatively mild winter temperatures. It should be budded high and deeply planted to improve anchorage and to reduce the strong tendency to produce root suckers. M.7 is a good producer of plants in the stoolbed, but in comparative orchard trials, fruit production on M.7 has not been impressive.

As a rootstock in the orchard, M.7 has a history of poor anchorage, low uptake of potassium and frost-tender roots. Fruit production is relatively light for the first 10 years, after which ladders are needed to pick the fruit. Except where previous experience has been favorable, growers are cautioned against making extensive plantings on M.7 especially from Ontario County east in Ontario. The use of new virus-free EMLA stock (not M.7A) may improve the performance of M.7.

Malling-Merton 106 makes a well-anchored tree whose size ranges from a large semi-dwarf to three-quarters of standard size or larger, depending on soil and cultivar. In comparative 12-year trials at Vineland and Simcoe, trees of McIntosh, Delicious and Northern Spy on MM.106 have demonstrated outstanding productivity. Like M.7, MM.106 has some susceptibility to collar rot, so that neither should be planted in old orchard sites where losses from collar rot have occurred. MM.106 is sensitive to moisture. Abundant rainfall late in the season sometimes delays maturity of the trees predisposing them to low temperature injury. Imperfect soil drainage can also result in loss of trees.

Where there is no objection to tree size, MM.106 is recommended for general planting on well-drained soils in Ontario, but only on a trial basis east of Hastings County. MM.106 is a good propagator in the stoolbed, rooting well and producing a stock of budding size the first year in the nursery. Though bred for woolly aphid resistance, it is not immune.

SEMI-VIGOROUS AND VIGOROUS TREES.

There appears to be little future for trees three-quarters of standard size or larger. They are slow to start cropping and costly to prune and pick.

Malling-Merton 111 is about the best in this class, although tree size is about 80% of standard. Though slightly more vigorous than M.2, the anchorage of MM.111 is better and the tree seems adaptable to a wider range of soil conditions. Commercial stocks of MM.111 are virus-free and appear resistant to collar rot.

MM.104 is not recommended as it is more vigorous than MM.111, and suffers losses from the combined effects of imperfect soil drainage and collar-rot infection.

Robusta 5 is no longer recommended as a root or body stock in Ontario. It has a very short rest period and may break dormancy during a mild spell in winter. A subsequent freeze can result in sunscald, bark-split, cambium injury and even death of the tree. Where no frost injury occurs, the trees are difficult to manage, being more vigorous than standards. Robusta 5 was developed at Ottawa and should be considered as a rootstock only in the coldest districts where the winter is not broken by mild spells.

OTHER ROOTSTOCKS

There are more rootstocks entering the picture every year. These stocks are still considered to be experimental

and are only being planted on a very limited basis for evaluation. Among these stocks are the MAC series (Michigan Apple Clone) which includes MARK, the Budagovsky series from Russia, (Bud 9, etc.) the Polish series (P1, P2, etc.) plus others.

VIRUS-TESTED ROOTSTOCKS

The old Malling stocks carried virus diseases. Released about 1960, M.9A, M.7A and M.2A are free of chat fruit, rubbery wood and apple mosaic but still carry the latents such as stem pitting, chlorotic leaf spot and spy epinasty.

In 1973, East Malling and Long Ashton released the EMLA clones of M.9, M.26, MM.106 and MM.111 that are free of the latent viruses as well as the other viruses. The elimination of virus content has resulted in greater vigor for each rootstock selection relative to its virus-infected parent. Preliminary reports indicate that virus-tested rootstock selections produce trees at least 10 to 15% larger than comparable trees on infected rootstock material. The Malling-Merton clones were never seriously infected but the EMLA clones of them are completely free of known viruses. Source material is also available in England of EMLA clones of M.2, M.7 and MM.104, but they are not being released to the trade unless there is a special demand as these rootstocks are considered obsolete in England.

DEPTH OF PLANTING

The proper depth at which to plant apple trees remains a very important issue. The bud union should be positioned 5 cm above the final soil level. To plant deeper may lead to the scion growing roots and the dwarfing influence of the rootstock being lost. To have the union excessively above the ground introduces the possibility of burrknots or aerial roots developing. This disruption in the bark can be invaded by the dogwood borer and lead to tree losses. For consistency of tree size and to reduce unnecessary trunk injury special care is required to properly position the bud union.

ORCHARD PLANTING DENSITIES

Orchard planting plans may be grouped into three general classes according to tree population (density) per hectare (Tables 1, 2 and 3).

(1) **Low Tree Density.** The spacing at planting time provides for full development of the tree, except for a minimum of training and corrective pruning. This plan requires the least investment per hectare in trees. Land must be cheap. It is usually necessary to intercrop while waiting the slow returns from the orchard. While wide tree spacing has been an accepted feature of the conventional orchard in the past, it is not recommended for orchards planted in the 90's. Projected life of the orchard is possibly 40 years.

(2) **Medium Tree Density**. The moderately close spacing of this plan requires a relatively high investment in trees, and in labor to manage them, which should be more than offset by increased returns. The trees are trained to a central leader. They are held to their allotted space by peripheral (surface) pruning, reducing the natural spread by at least 20%, essentially a moderate mold and hold. The medium density is recommended for the average orchardist. Projected orchard lifetime about 20 years.

(3) **High Tree Density.** The higher the tree population, the greater the need to program the management system for the life of the orchard. Many variations in plan are possible. Dwarfing stocks are preferred. The possible advantage of earlier returns is offset against greater cost per hectare for trees.

Methods of training and pruning must be very specialized to control tree size and induce early cropping.

For freestanding trees, types of training may be central leader as with spur types, modified central leader with standard growth types, or dwarf pyramid. Trees on a 2- or 4-wire trellis may be trained to a fan shape or palmette. Once tree framework is established on the trellis, much of the pruning may be done with a mechanical hedger to maintain a tree wall. With trees on M.26 the posts and wires may be removed when the framework is established. Trees on M.9 tied to posts may be trained as slender spindles, especially at very close planting.

There is also the possible need for irrigation, and the risk of fruit color and size declining as trees reach greater size at maturity. Fruit color and size decline as exposure to

Table 1. Suggested spacing in metres (m) of apple cultivars of average vigor on certain leading rootstocks

Rootstock	Low Density	Medium Density	High Density
M.9	— —	2.5 x 5.0	1.8 x 3.5
M.26	5.0 x 7.5	3.5 x 6.0	2.5 x 4.5
M.7	5.5 x 8.0	4.5 x 6.5	3 x 4.5
MM.106, M.2	6.0 x 8.5	5.0 x 7.5	3.5 x 7.5
MM.111	6.5 x 9.0	5.5 x 8.0	— —
Vigorous Rootstocks	7.5 x 10.0	6.0 x 8.5	— —

light decreases. Quality is as important a factor in profits as is quantity. Small high-density plantings are warranted, especially with spur-type cultivars and others such as Idared and Empire. Projected lifetime of the orchard is possibly 12 to 15 years.

A guide to tree spacings for each of the different orchard densities is given in Table 1. The suggested spacings in the table are for soils of average fertility and cultivars of average vigor.

In general, tree spacings for different levels of soil fertility should be adjusted in one or both directions as follows:

for low-fertility soils subtract 0.5 m
for high-fertility soils add 0.5 m

Table 2 suggests the maximum adjustment in spacing for cultivars that are smaller or larger than average size. Example: Following the guidelines in Tables 1 and 2 and the text, Idared on MM. 106 at medium density would be planted in an average soil at 4.5 x 6.5 m, on a low-fertility soil at 3.5 x 6.0 m, and on a high-fertility soil at 5.0 x 7.5 m or 5.0 x 6.5 m.

Table 2. Adjustment * of spacings given in Table 1 according to the natural size of fruiting cultivar

Rate of growth	Low density	Medium density	High density
Slow – Spur types	minus 1 m	minus 1 m	minus 0.5 m
Spur McIntosh	both directions	both directions	both directions
Spur Delicious			
Medium – Idared	minus 0.5 m	minus 0.5 m	minus 0.5 m
Golden Delicious	both directions	both directions	both directions
Empire			
Vigorous – Delicious,		as outlined in Table 1	
McIntosh, Spartan			
Very Vigorous –	add 0.5 m	add 0.5 m	not applicable
Northern Spy	both directions	both directions	

* The adjustments for cultivar and soil for each rootstock have been presented and described by George Whaley, Ruthven, Ontario, as the Natural Dimension Factor (cultivar+rootstock+soil). Each item within the foregoing brackets is given a numerical value so that the sum is the natural spread of the tree and a guide to spacing for the particular orchard.

Table 3. Number of trees per hectare at various spacings[2]

Distance between trees (m)	Distance between rows (m)																
	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5	8	8.5	9	9.5	10
1.5	3333	2667	2222	1905	1667												
2	2500	2000	1667	1428	1250	1111	1000	909									
2.5		1600	1333	1143	1000	889	800	727	667								
3			1111	952	833	741	667	606	555	513							
3.5				816	714	635	571	519	476	440	408						
4					625	555	500	455	417	385	357	333					
4.5						494	444	404	370	342	317	296	278				
5							400	364	333	308	286	267	250	235			
5.5								330	303	279	260	242	227	214	202		
6									278	256	238	222	208	196	185	175	
6.5										236	220	205	192	181	171	162	154
7											204	190	178	168	159	150	143

[2]*To find number of trees /ha at any other metric planting distances, multiply distance between trees (m) by distance between rows (m) and divide 10,000 by that product.*

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